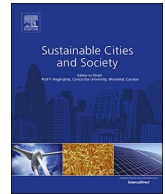




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An evaluation of fire safety measures in high-rise buildings in Nigeria

Pontip Stephen Nimlyat*, Ahmed Umar Audu, Erekpitan Omoikhefe Ola-Adisa, Detur Gwatau

Department of Architecture, University of Jos, Nigeria

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ABSTRACT

Fire disaster happens to be one of the world's most common and destructive disasters. It has over the years been a disturbing issue to handle most especially in developing countries. This study aimed at evaluating fire safety measures in the design and construction of high-rise buildings in Nigeria. The importance of this study is the evaluation of fire safety measures towards enhancing the safety of occupants and properties. The study consisted of a case study survey and questionnaire administration among the building occupants. The occupant survey is to determine their perceptions of fire safety measures in high-rise buildings and the practicability of measures that could be adopted to improve safety. From the occupant survey, 88% of the respondents have awareness on fire safety measures in buildings. The results also indicated that the most common causes of fire incidences in high-rise buildings are an electrical fault. This could be avoided where electrical conduits and fittings are properly installed and monitored. The results further revealed the need to improve on fire safety measures undertaken by both designers and property owners. A careful observance of fire safety measures as specified in building codes must be considered in the design of high-rise buildings.

1. Introduction

In Nigeria today, buildings are faced with a variety of problems especially in high-rise buildings which are characterized by heights and extended vertical travel distance for the egress and means of access which imposes fire protection challenges. From experience and general knowledge, fire disaster happens to be one of the world's most common and destructive disasters. It has over the years been a disturbing issue to handle most especially in developing countries. Naturally, when a fire is restricted to a certain degree and is controlled, it keeps spaces warm and makes the production of new materials possible through recycling among other production methods. On the other hand, when it gets out of control, it destroys lives, properties, and businesses. Sometimes people that have experienced fire outbreak have been affected psychologically, in some cases, it is the trauma that leads to their death and not the injuries sustained. The after effect of fire disaster on buildings is not easily corrected and even if it is corrected, it hardly stands the test of time.

High-rise buildings have a greater risk of fire according to its features such as great height, complex structure, and diverse functions, and so on (Hassanain, 2009). However, this assertion might not be true as high-rise buildings are designed with specific fire protection features. A report on high-rise buildings fires conducted by the US National Fire Protection Association (Ahrens, 2016), have shown that fire occurrences in high-rise buildings are less compared to other buildings of the

same property use that have been gutted by fire. This is due to the fact that the design and construction of buildings with automatic fire protection and prevention equipment are more common with high-rise buildings than other building facilities. On the other hand, the need for fire prevention and protection in high-rise buildings is paramount due to the fact that the occupancy level is always high and the distance to exit discharge is longer (Ahrens, 2016). Furthermore, it is easy to cause more casualties and property losses once a high-rise building is on fire.

The challenges posed by high-rise buildings within the built environment is both to the building occupants and the firefighting agencies. Therefore, it is of great significance through the fire-safety evaluation, to prevent the occurrence of high-rise building fire in time (Dechamps et al., 2011). However, with the aid of science and technology knowledge in the field of fire protection is undergoing development and recognition that will enable buildings to be designed for fire safety more rationally and efficiently. Over the years, concepts and criteria were developed which enabled safe high-rise buildings to be built (Devanahalli, 2015). Some of these developments are the improvement on fire resistant materials that can help a man in effective fire protection in buildings alongside the use of resistant materials that can withstand the high temperature of heat to a certain degree. For example, the fire resistivity quality and properties of concrete performing at elevated temperature have been improved through cement replacement with certain percentages of pozzolana (Morsy, Shebl, & Rashad, 2009; Nimlyat & Datok, 2013). All these are

* Corresponding author.

E-mail addresses: pontipn@unijos.edu.ng, psnimlyat2@live.utm.my (P.S. Nimlyat).<http://dx.doi.org/10.1016/j.scs.2017.08.035>Received 19 October 2016; Received in revised form 30 August 2017; Accepted 30 August 2017
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complimented with some design principles, which help in enhancing the performance of high-rise buildings under fire condition to ensure the security of lives and properties in a sustainable built environment.

A study carried out by [Tofiloa et al. \(2013\)](#), identified about eleven (11) parametric modules towards building fire safety analysis and risk assessment. The application of these parametric modules will bring about improvement in national building and construction process for fire safety engineering. [Cowlard, Bittern, Abecassis-Empis, and Torero \(2013\)](#) on their part carried out an assessment of high-rise buildings to measure their design effectiveness in meeting global performance fire safety objectives, as well as, ascertaining the state-of-the-art of fire safety measures and guidance adopted. They identified open plan compartments in fire safety design for high-rise buildings as critical in achieving their performance objectives. These and other earlier studies have shown a great deal of research, which have underpinned the fire protection recommendations for high-rise buildings.

In recent times, there has been a high Concern towards fire safety issues in high-rise buildings in Nigeria due to several fire incidences that have occurred. [Tolofari \(2010\)](#), a disaster management expert, has put the annual fire outbreak in Nigeria at about 7000 with resultant deaths of over 1000 persons. As also noted by [Wakili \(2013\)](#), over Two Hundred and Fifty Million Dollar is lost annually in Nigeria due to fire disasters. The increase in the rate of fire outbreak is a clear indication that it needs to be prevented as technology improves. As a result of this, the Nigeria Federal Government had approved the First Edition of the National Building Code (NBC), as well as, endorsed a draft National Fire and Safety Code for implementation and enforcement all over the country. These performance based building and fire safety codes have been adopted towards ameliorating the extent effects of fire disasters which have ravaged the country in time past. The drafting of the Nigerian National Building Code took almost about 19 years before the first edition was finally signed as an acceptable document in 2006. In the Nigeria NBC however, the need for fire safety was not elaborated as references were severally made to the National Fire Safety Code. Also, the implementation of this building code which is supposed to put an end or reduction to the ugly trends in the building industry is still of great concern to the professionals in the field, as the enforcement is still at its ebb. In recent times, however, there has been a wide spread called on the enforcement of the approved National Fire Safety Code at all levels due to the incessant cases of fire disasters that have resulted in the loss of lives and properties ([Ayodele, 2016](#)). In view of this case, we need to improvise improved means of resisting failure of building structures all through the design processes.

It is observed that the vast number of casualties evacuated from any incident of a fire outbreak in high-rise buildings is as a result of the lack of attention given to the safety measures for occupants, in the process of the design or construction of such buildings by architects or engineers. Some designers do not realize that safety measures in high-rise buildings are important as well as the spaces created in the buildings. Therefore, the need for a fire defense plan in high-rise buildings among other buildings is necessary. In order for building designers and engineers to be able to identify measures towards building performance improvement, an evaluation of fire safety measures in high-rise buildings system is paramount. The aim of this study, therefore, is to evaluate and estimate the performance of fire-safety measures and factors that should be considered when designing a high-rise building to enable the protection of the lives and properties of the occupants of such buildings. Furthermore, it is aimed at creating more awareness especially among occupants in high-rise buildings on fire safety measures, and fire-safety precautions taken in high-rise buildings. This study would provide the basis for more awareness in facilitating an increasing role of building design professionals in fire safety measures.

2. Fire safety management in high-rise buildings

Fire safety may be defined as goals and aims such as fire prevention,

fire control and occupant protection which normally can be found in the introductory section of building code and other fire safety legislation ([Rasbash, Ramachandran, Kandola, Watts, & Law, 2004](#)). According to [Howarth and Kara-Zaitri \(1999\)](#), fire safety management can be defined as the application of fire safety measures by a manager of policy, standards, tools, information, and practices to the task of analyzing, evaluating and controlling fire safety. Consequently, fire safety management could be said to be a structured approach, generally based on a fire safety policy to ensure your duties under the fire safety order are effectively complied with. It is true that fire safety management does not necessarily mean that fire occurrences are eradicated completely from the buildings that observe the codes and standards, but fires are minimized so that lives and properties are safe from destruction. Fire management in high-rise buildings makes it possible for the appropriate choice of materials to be used in the buildings so that the buildings can be able to withstand some certain degree of fire resistivity to save guard the structure from damage and immediate collapse. There is, therefore, a need for already existing high-rise buildings in Nigeria without proper fire prevention and protection measures to be identified and retrofitted in line with existing guidelines and codes. As according to the [National Fire Protection Association \(NFPA\) 101 \(2015\)](#), retrofitting of such buildings will make them safer for the occupants.

Over the years there has been a lot of interest in fire safety management, and as time passes, new ideas and materials are been discovered to improve on fire safety in buildings especially high-rise buildings. Fire became an ecological factor whose patterns continue to influence evolution ([McGrath, 2003](#)). Several countries of the world including Nigeria, have recommended through different codes and guidelines, fire protection systems and strategies for high-rise buildings. The incident that occurred at the World Trade Center (WTC) in September 2001, has led to the demand for the provision of a certain acceptable level of safety in high-rise buildings. This is the fatal high-rise building fire incident that has occurred in history. The incidence left not less than 2666 people death aside from the property lost ([Ahrens, 2016](#)). But even with the different compilation of technical explanation on this incidence, it still fails to theorize the implications that high-rise buildings present to outmoded fire safety measures ([Cowlard et al., 2013](#)).

The assessment of a building in terms of fire safety as contained in the Nigeria National NBC includes but not limited to,

- i Fire safety measures such as structural fire resistance, detection, alarm and extinguishing systems.
- ii Measures of egress inclusive of configuration characteristics and support features.
- iii A general safety such as fire safety parameters and means of egress parameters.

The Nigeria NBC provided for the installation of smoke detectors at each elevator lobby, provision of designated main floor level for emergency personnel for firefighting or rescue purpose ([Nigerian National Building Code, 2006](#)). Among other needs and requirements, fire safety awareness campaign and life safety education to the general public form part of the Nigeria NBC scope. Fire safety strategies for high-rise buildings is divided into two basic components; egress strategy and building performance strategy ([Cowlard et al., 2013](#)). The building performance aspect is a factor of the performance of the building structure, and also the mitigation of fire spread in form of compartmentation. The egress strategy (evacuation) on the other hand, depends on the amount of time required to completely evacuate all occupants in a building. There is likely an interphase between evacuation and compartmentation failure in buildings as seen in the case of the fire incidence that occurred on the World Trade Center (WTC). This overlapping problem will further intensify with increased in building complexity and height, as opined by [Cowlard et al. \(2013\)](#).

Furthermore, there are certain variables that are related to a

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